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ABSTRACT

This report describes research on Bartlett's theory of constructive memory. In experiment one, schematic retention is related to Tulving's distinction between episodic and semantic memory. With the passage of time, memory for prose reflects decreasing output from episodic memory and increasing output from semantic memory. In experiment two, Bartlett's theory is related to Craik and Lockhart's levels-of-processing framework. Comprehension of prose involves the creation of multiple codes which are forgotten at different rates. Bartlett's schema is interpreted as a higher-level code that is exceptionally durable over long intervals. The research supports the validity of Bartlett's theory. (Author)

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Episodic and Semantic Aspects of Memory for Prose[1]

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The research I will describe this morning represents an attempt to do modern experimentation on Bartlett's (1932) theory of memory. The appeal of Bartlett for me has been his emphasis on natural, real-world remembering. Psychology has recently passed through a highly analytic phase where counterintuitive findings were highly regarded. But the present dominance of cognitive psychology has changed all that. We are now distrustful and wary of any experimental result which contradicts our intuition and common sense. We are now afraid of being irrelevant. We have come to realize that the study of memory must include cognitive structures that would never be discovered in an Ebbinghaus (1885) approach. As Jenkins (1974) pointed out, what is basic and simple for the study of memory is not at all clear. By analogy, if we wanted to study vehicular transportation, the law of parsimony would not force us to start with its simplest exemplar--the unicycle. In psychology, too much of our time and energy has already been expended on the study of the unicycle. If we want to understand human memory, we are going to have to study the remembering of meaningful material in all its complexity.

My initial research on Bartlett's theory focused on the fact that an abstract, schematic structure has facilitative effects on recall. For example, if you give subjects the "theme" of a passage that is otherwise incomprehensible, they remember the words better (e.g., Dooling & Lachman, 1971; Dooling & Mullet, 1973). In these studies, the schema was viewed as an organizer, a mnemonic device. While I do believe that it does serve this function, the great amount of contemporary research on mnemonic devices has unfortunately focused on an atypical aspect of human memory: the use of mnemonic devices to improve rote recall. Bartlett knew that human memory is anything but verbatim--and so does the person on the street. In recognition of this fact, many of the important memory experiments in recent years have focused on the "errors" that subjects make, rather than on their "correct" reproductions. By analyzing errors for their thematic and semantic content, we have been able to learn much about the way in which the material was originally encoded. Of course, from this perspective, a thematic error is not actually an error. While subjects are notoriously lousy at exact reproduction of words and sentences, they are excellent at preserving the "gist" and "general idea" of a passage.

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The research I will talk about this morning employs the false recognition technique on sentences from connected discourse. When a subject falsely recognizes a sentence that was not in the original passage, the "error" gives us an important clue as to how the passage is represented in memory.

Experiment I

One of Bartlett's best known findings is that recall becomes more abstract, more thematic, and more coherent with the passage of time. Details are forgotten and thematic intrusion errors increase. My first experiment is an attempt to demonstrate just such an effect. The experiment can be interpretted in more modern terms by considering Tulving's (1972) distinction between episodic and semantic memory. We can consider the words of a passage as "episodes" coded for time and place; these are quickly forgotten with the passage of time. In the absence of specific, memory for individual word occurrences, subjects rely on their semantic memory--their knowledge. It is perhaps the essence of constructive memory processes that the contribution of semantic memory increases as memory for detail fades away.

Experiment I is a follow-up to a study I published last year with Becky Sulin (Sulin & Dooling, 1974). In the Sulin & Dooling experiment we manipulated the subjects' knowledge of a topic by giving them a passage that was about either a fictitious or a famous person. For example, the first passage in Table 1 is about a ruthless dictator named Gerald Martin. If we change the name of the main character to Adolph Hitler, we manipulate the amount of knowledge that subjects have about the topic. In the Famous condition, subjects can make greater use of their semantic memory. We tested recognition memory for sentences from the passage, as well as for sentences that had not been read by the subjects--the recognition foils. As shown at the bottom of Table 1, some of the foils had nothing to do with the Famous main character, while others varied in their degree of thematic relatedness. Slide 1 shows the false recognition of foils sentences for two retention intervals. At the short, 5-minute retention interval, there are few false recognitions and the Famous-Fictitious manipulation had no effect. The subjects remembered enough of the sentences as specific episodes to perform well on the test. At one week, however, there is a pronounced thematic effect. Subjects who have read about a famous person rely more on their pre-experimental knowledge about the person in making their recognition decision. We could say that the loss of episodic information has led to an increasing reliance on output from semantic memory.

Experiment I is addressed to the same topic as the Sulin & Dooling experiment. It also uses the same materials. In this study Bob Christiaansen and I set out to introduce a new manipulation that would provide a converging operation for substantiating the conclusions reached by Sulin & Dooling. We added a third group of subjects who read about the Fictitious main character; but before the recognition test, they were told that the passage had actually been about the Famous main character, for example, Adolph Hitler. The subjects in this "After" group would encode the information the same as in the Fictitious condition. But at the time of the recognition test, they would have available their semantic knowledge of the Famous person. We expected the performance of the After group to be the same as the Fictitious group at short retention intervals where memory for specific episodes is good. At a very long retention interval, however, the After group should perform like the Famous group, reflecting the total loss of specific memory and total reliance on semantic knowledge.

We chose two intermediate retention intervals for the experiment: two days vs one week. The results are shown in Slide 2. Here again, we show percent "Yes" responses to sentences that had not occurred in the passage. At the two-day retention interval, the After group is just as accurate as the Fictitious group in ruling out thematic foils. But at one week, the performance of the After group has risen to an intermediate level. Because the data at one week appeared to be a little sloppy, we have replicated the one-week experiment twice. Both times the results were sloppy--but in different ways--and both times the After group performed thematically between the Famous and Fictitious groups. We are quite confident, therefore, that the After group performs more thematically at one week than at two days. The results show an increasing reliance on semantic memory with the passage of time.[2] We should also notice that in terms of the Famous-Fictitious manipulation, we obtain a thematic effect at two days that increases in magnitude at one week.

Experiment II

The results of Experiment I are consistent with Bartlett's theory. They also show differential episodic and semantic memory effects with the passage of time. As we continued our research on constructive memory processes, we found the episodic-semantic distinction to be less useful. Our use of the distinction set up a dichotomy that did not do just to the encoding and retrieval processes involved in memory for connected discourse. We chose, instead, to interpret our results, by relating Bartlett's theory to the levels-of-processing framework described by Craik and

Lockhart (1972).

Craik and Lockhart (1972) emphasize that information for a memory experiment can be encoded at various levels. The higher the level of encoding, the longer the duration of the memory. Much of the research on levels of processing has manipulated encoding strategies to show that different codes have different retention effects. What I would like to emphasize is that comprehension of connected discourse involves the simultaneous activation of multiple codes at different levels. With the passage of time, lower codes are lost first, while higher codes remain. Kintsch (1974) has recently made a similar suggestion about the retention of connected discourse.

What the levels-of-processing view has in common with Bartlett is an emphasis on the intimate relationship between perception and memory: what you perceive is what you get. Perception involves activation of semantic memory which can vary from fairly superficial aspects of the material to the perception of new semantic relationships. We might tentatively consider Bartlett's schema to be the highest level of such codes: the perception by the subject that a relatively permanent memory structure captures much of the meaning of the material to be remembered.

The second experiment was performed in collaboration with Bob Christiaansen and Tom Keenan. The materials we used are shown on the second page of the handout (Table 2). We first constructed an Abstract passage. It is abstract in the sense that it can have two different specific themes: The Climbing of Mount Everest or NASA Mission to the Moon. We then created a specific version for each topic by making a few strategic lexical substitutions and, in some cases, phrase substitutions. For example, in the Abstract version there is an "unexpected occurrence." In the Mountain passage this becomes an "unexpected avalanche", while it is an "unexpected meteor" in the Moon story. With these materials, we could present essentially the same story, using different types of sentences.

Each subject in the experiment was given one reading of either the Mountain or Moon passage. For this experiment, the passages were presented in mixed format[3], as shown in Table 3. For example, the first sentence is from the Abstract version, the second is specific, etc. Each subject read a passage that had one sentence omitted. This could be any one of the sentences 2 through 9. In our example, the fourth sentence has been omitted: "Only the best

mountaineers were chosen for the ascent." Four different retention intervals were employed, with about 200 subjects serving in each condition: 7 minutes, 2 days, 1 week, or 1 month.

After the appropriate retention interval, the subjects were given a recognition test on a single sentence.[4] They were to respond Yes or No and give an indication of confidence on a three-point scale. The various test conditions are outlined at the bottom of Table 3. Condition IN-SAME refers to the case where the subject was presented with one of the sentences that was in the passage. This is the only condition in which Yes is the "correct" response. In condition IN-DIFFERENT, subjects are also tested on a sentence that had been in the passage, but in this case the format has been reversed. In our example, the subject read a specific passage about an "avalanche" and was tested on the abstract version of the same sentence. Other subjects were tested on an "Out" sentence, one that had not actually occurred in the passage. These are, however, consistent with the theme of the passage. Such test sentences could be either abstract or specific, creating the two conditions OUT-SAME or OUT-DIFFERENT. Because the same vs different refers to characteristics of sentences not read by the subjects, the two "Out" conditions can be considered the same for conceptual purposes. In fact, we did not run condition OUT-SAME at all of the retention intervals. Lastly, we have a non-thematic condition where subjects are presented with a specific sentence that did not match the theme of the passage which they read. This condition was run at only the one-month interval.

These materials allow us to vary the semantic relationship between a recognition foil sentence and the actual material read at various levels. We expected that subjects would forget sentence format before sentence meaning. We also predicted that they would forget the "gist" of individual sentences, while still remembering the theme.

The results are summarized in Table 4. We show the percentage of "Yes" responses under the various experimental conditions. In order to conserve subjects we did not run certain non-essential conditions at various retention intervals. Although we omitted some cells, the specific-abstract format provided two replications of the same experiment.[5] We have complete data for the case where the target sentence was abstract; these data (which are underlined in the table) are shown graphically in Slide 3. Yes responses for sentences that were actually in the passage decline slowly with the passage of time, reaching an apparent asymptote at 67%.

False recognitions of sentences with similar meaning increase with the passage of time as subjects lose sentence format information. False recognitions of thematically related "out" sentences also increase with the passage of time, but subjects still have some memory for specific sentence meanings even at one month. The non-thematic condition shows that memory for the "theme" is excellent at a one-month retention interval. Slide 4 shows the same data when confidence scores are figures in with the Yes-No responses. For example, a score of 6 represents a high-confidence "Yes" response, while a 1 represents a high-confidence "No" response. The pattern of results is pretty much the same.

I would like to make several points about these data from Experiment II:

1. The results are consistent both with Bartlett's theory and the levels-of-processing framework. With Bartlett, we could say that subjects lose specific information with the passage of time, while an abstract schema remains. With Craik and Lockhart, we could say that language can be encoded at many levels, and that higher-level codes are more durable than the lower ones. In the present study, we could roughly characterize three levels of codes: word meanings, sentence meanings, and passage meaning.

2. We should stress the present view that the different codes simultaneously co-exist after initial perception. Some views of constructive memory processes have implied that meaningful material is abstractly encoded and all other information is immediately lost. It would be more reasonable to suggest that the comprehension of a passage--its perception--creates numerous memory codes, which are forgotten at different rates.

3. The present results might also help to clarify what happens to a schema with the passage of time. There is a tendency to interpret Bartlett's views from a Gestalt perspective and to view the schema as becoming normalized with the passage of time. One gets the idea that subjects have schemata growing inside them during the retention interval. My present view is that recall becomes more thematic with the passage of time because of the loss of lower-level codes. The schema itself doesn't change.

4. At first, we were surprised when the various retention functions (Slide 3) did not asymptote at 50%. We expected, for example, that the two different formats (IN-SAME vs IN-DIFF) would yield chance performance at the longer retention intervals. Although a forced-choice procedure between the two probably would yield

something close to 50%, subjects respond "Yes" about two thirds of the time under either of the present conditions. Clearly they are responding on the basis of the theme. This reflects an important component of constructive memory: Subjects respond on the basis of whatever information they have in memory, however vague and imprecise it might be.

5. When we initially designed this study, we were predicting differences as a function of the specific-abstract dimension. According to Bartlett, memory becomes more abstract with the passage of time. We therefore expected more false recognitions of abstract foils at the longer retention intervals. The results did not bear out this prediction. Abstract foils did lead to more false recognitions, but the tendency did not increase systematically with the passage of time. This is probably due to some sort of response bias caused by the fact that abstract statements have a wider range of meanings that might be included. While we still think that memory does become more abstract with the passage of time, we do not think that such effects can be demonstrated with the false recognition technique. At long retention intervals, it is likely that subjects abstract out the "gist" of the foil--whatever its format--and make their memory decision on the basis of this abstraction.

Conclusion

The research I have described this morning can be taken as support for Bartlett's theory of memory. The theory itself is broad and vague and in need of further elaboration. I don't know if my speculations about episodic and semantic memory or levels of processing have brought us any closer to a more satisfying theory of constructive memory processes. But I do take comfort in the fact that the experimental results I have reported are intuitively appealing. The person on the street would consider them sensible. This gives me some confidence that we are on the right track.

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Footnotes

[1]I am grateful to the following for their assistance in this paper: Robert E. Christiaansen and Thomas F. Keenan, who collaborated on some of the research described here; to Debra Shutts, David Payne and Heather Turnbull, who assisted in subject-running and data analysis; to Joseph H. Danks, who critically read a previous version of this paper.

[2]A fourth condition was actually run in the experiment, but is not described here for the sake of brevity. This group, called the "Before" group, read a Fictitious passage having been told ahead that it was really about the famous person. Performance in this condition was virtually the same as for the Famous group.

[3]Presentation of pure specific or pure abstract passages yields slightly different recognition results due to the fact that subjects remember the "style" of the passage.

[4]At the seven minute retention interval we used a conventional recognition test in which each subject responded to multiple sentences. We analyzed for position in the test deck and found significant interactions with the test conditions. We concluded that the recognition test itself is a source of "constructive" errors. We therefore report data on only one recognition sentence per subject.

[5]The data in Figure 3 are taken from half the cells in Table 4 those labeled "Abstract" on the left. This is done because of missing "Specific" cells at the one month interval.

Episodic and Semantic Aspects of Memory for Prose

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Handout

Table 1

Example of Passages and Foil Sentences used in Experiment I

(from Sulin & Dooling, 1974)

Fictitious Main Character: Gerald Martin's seizure of power

Gerald Martin strove to undermine the existing government to satisfy his political ambitions. Many of the people of his country supported his efforts. Current political problems made it relatively easy for Martin to take over. Certain groups remained loyal to the old government and caused Martin trouble. He confronted these groups directly and so silenced them. He became a ruthless, uncontrollable dictator. The ultimate effect of his rule was the downfall of his country.

Famous Main Character: Adolf Hitler's seizure of power

Adolf Hitler strove to undermine the existing government to satify his political ambitions. Many of the people of his country supported his efforts. (etc.)

Recognition Foil Sentences:

Neutral: 1. By the time Martin (Hitler) turned eight, he was still unmanageable.

2. There was no good institution for Martin's (Hitler's) problem in his state.

3. His parents finally decided to take some action.

4. They hired a private teacher for him.

Thematic:

Low--He was an intelligent man, but had no sense of human kindness.

Medium--He was obsessed with a desire to conquer the world.

High--He hated the Jews particularly and so persecuted them.

Table 2

Passages used in Experiment II
(Dooling, Christiaansen, & Keenan)

Abstract:

Man's curiosity had led him to the challenge of the unknown. Those in charge had made careful plans for the attempt. The equipment had been meticulously checked and double-checked. Only the best men were chosen for the task. It was necessary to consider many variables in calculating a precise time for the event. When the day arrived, the participants were made ready and transported to the site. The beginning went smoothly and quickly. Midway, an unexpected occurrence caused danger and was skillfully avoided. The last part required total concentration and expertise. There was an historic moment of triumph when the goal was finally reached.

Specific: The Climbing of Mount Everest

Man's curiosity had led him to the challenge of Mt. Everest. Everest experts had made careful plans for the climb. The climbing gear had been meticulously checked and double-checked. Only the best mountaineers were chosen for the ascent. It was necessary to consider both ground-level and summit weather conditions in calculating a precise time for the climb. When the day arrived, the climbers were outfitted and flown into the Himalayan base camp. The early climbing went smoothly and quickly. Midway, an unexpected avalanche caused danger and was skillfully avoided. The final ascent to the summit, required total concentration and physical prowess. There was an historic moment of triumph when the summit of Mt. Everest was finally reached.

Specific: NASA Mission to the Moon

Man's curiosity had led him to the challenge of the moon. NASA officials had made careful plans for the flight. The rocket had been meticulously checked and double-checked. Only the best astronauts were chosen for the mission. It was necessary to consider both earthly weather and lunar position in calculating a precise time for the flight. When the day arrived, the astronauts were suited up and driven to the launch pad. The take-off went smoothly and quickly. Midway, an unexpected meteor caused danger and was skillfully avoided. The final descent to the moon's surface required total concentration and quick wits. There was an historic moment of triumph when the moon's surface was finally reached.

Table 3

Example of the Type of Mixed Passages

Actually Read by Subjects

Subject Reads:

The Climbing of Mount Everest

Man's curiosity had led him to the challenge of the unknown.

Everest experts had made careful plans for the climb.

The equipment had been meticulously checked and double-checked.

OUT → It was necessary to consider many variables in calculating a precise time for the event.

When the day arrived, the climbers were outfitted and flown into the Himalayan base camp.

The beginning went smoothly and quickly.

IN → Midway, an unexpected avalanche caused danger and was skillfully avoided.

The last part required total concentration and expertise.

There was an historic moment of triumph when the summit of Mt. Everest was finally reached.

Test Conditions:

In-Same: Midway, an unexpected avalanche caused danger and was skillfully avoided.

In-Different: Midway, an unexpected occurrence caused danger and was skillfully avoided.

Out-Same: Only the best mountaineers were chosen for the ascent.

Out-Different: Only the best men were chosen for the task.

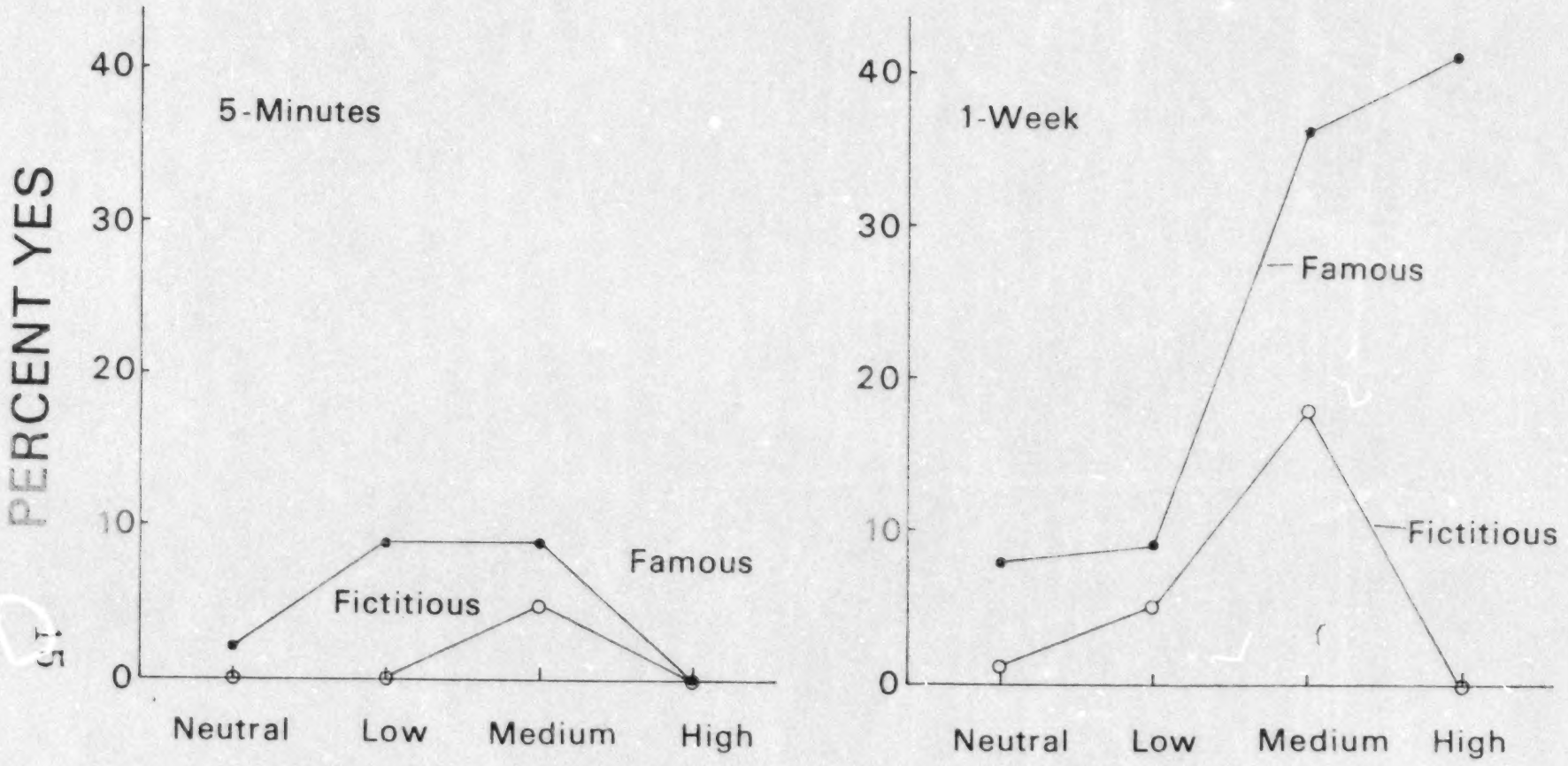
Non-Thematic: Only the best astronauts were chosen for the mission.

Table 4

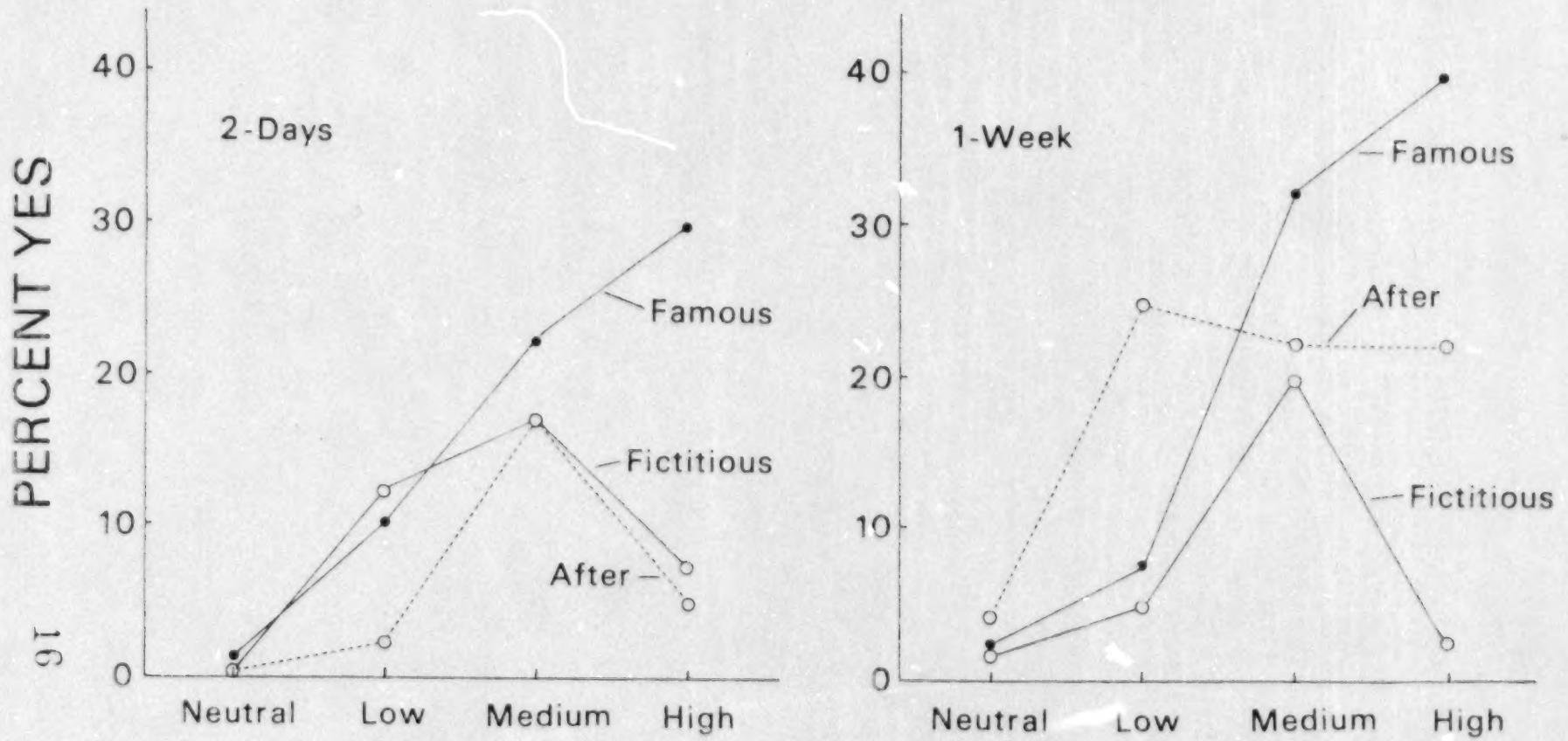
Percent Yes Responses in Experiment II
(Dooling, Christiaansen, & Keenan)

Retention Interval	Sentence Format In/Out of Passage	Test Conditions				
		In-Same	In-Diff	Out-Same	Out-Diff	Non-Thematic
7-Minutes	Specific	71	42	12	12	-
	Abstract	75	33	8	4	-
2-Days	Specific	67	54	-	46	-
	Abstract	71	42	-	33	-
1-Week	Specific	54	54	-	33	-
	Abstract	67	58	-	25	-
1-Month	Specific	-	69	46	-	4
	Abstract	67	65	-	38	-
Levels of Meaning						
Same Exact Words		+	-			
Same Sentence Gist		+	+	-	-	
Same Theme		+	+	+	+	-

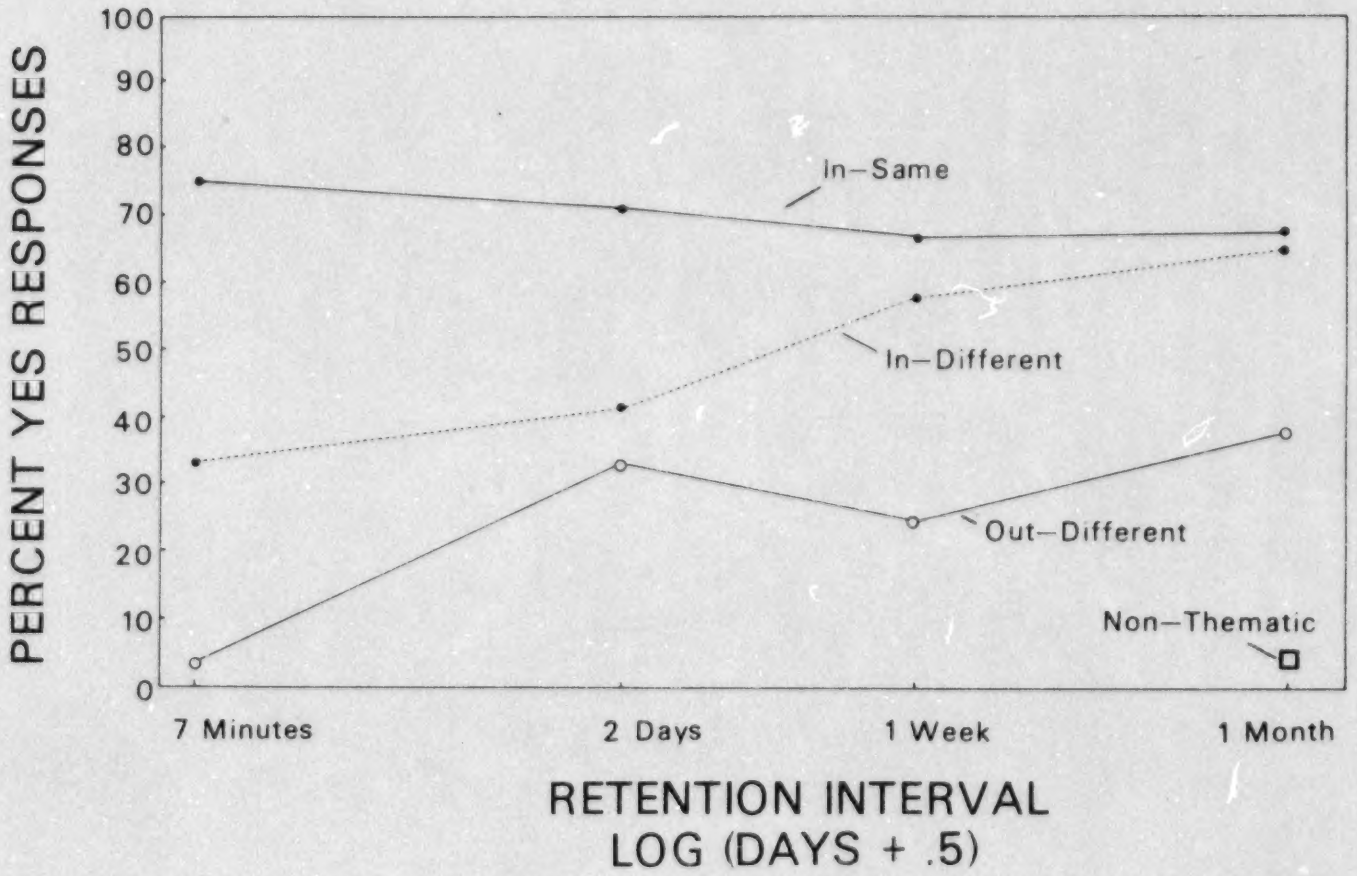
SULIN AND DOOLING (1974)



EXPERIMENT I (DOOLING AND CHRISTIAANSEN)



THEMATIC RELATEDNESS


PERCENT YES RESPONSES
100
90
80
70
60
50
40
30
20
10
0
In–Same
In–Different
Out–Different
Non–Thematic
7 Minutes
2 Days
1 Week
1 Month
RETENTION INTERVAL
LOG (DAYS + .5)

EXPERIMENT II (DOOLING, CHRISTIAANSEN, & KEENAN)